rains, are made ready to receive the seed which in November and December is scattered broadcast, mixed with wheat and lightly covered over after heavy rain. The green seedlings appear in a few weeks, but there is no tangible development until the wheat is taken away and the decaying stalks have become available as plant-food, and perhaps advantageously helped by a thin surface-dressing of sawdust.

A Pinaster plantation soon becomes productive, yielding in the first years substantial bedding for cattle and, mixed with dried gorse bushes, excellent material for the ovens in the village bakehouses. In four or five years the crop will yield abundantly supporting stakes, 6–8 ft. long, for the climbing beans on which the Madeira peasant so largely depends for his winter food, and, yearly afterwards, sturdy poles in ever-increasing dimensions for the construction of the fascinating trellises in the famous vineyards at a lower level. In twelve or fifteen years the trees have attained the stage of firewood, and, with the exception of a few selected pines left for timber, the ground is once more cleared for planting afresh. The tree-stumps are mostly grubbed up, but those left quickly decay in the ground, and the Pinaster throws up no fresh shoots after cutting. The young Pinaster has a distinct tap-root, but the roots of the mature tree spread in a superficial mat, twining fantastically along the surface among the protruding rocks. In digging the foundations of a lofty tower I met with no roots deeper than 4 ft.

No attempt has hitherto been made to deal with the abundant store of turpentine and resin with which in this region the Pinaster is endowed; and up to the present time the plantations have not suffered from the blights and diseases to which the species is subject elsewhere.

Much Pinaster seed is imported from Portugal, as less costly than collecting locally, but the full-bodied, delicately winged seed from a mature tree is in every way preferable, and to procure it a young, supple-limbed mountaineer will not hesitate over the perilous ascent of the huge trunk, bare of branches 70–80 ft. from the ground. A frail ladder made of ivy-stalk serves his purpose, pegged by segments into the crevices of the rough bark, and on reaching the first horizontal branch the intrepid fellow will pass down a string to a companion and draw up a long pine sapling, and with this, clambering out upon the branch, he will beat down the cone clusters with their prolific crop. Once in three or four years sufficient cones have developed to tempt the climber to this giddy and blood-curdling enterprise, and the seeds are beaten out in a few days when the sunshine has sufficiently opened the cones. The seeds then become the property of the pine steeplejack, the handsome, cinnamon-coloured cones, with the substantial residuum of unextracted seeds, remaining with the landowner.

Pinaster timber of mature growth is a handsome and useful wood, though more difficult to work than the imported deals from America and Norway. I possess some substantial floors which show no signs of decay after thirty years' service.

For general purposes Pinaster is far the most serviceable conifer yet seen in Madeira, and its quick growth, its prolific yield of cones and seeds, and its hardy nature and easy cultivation have given the species a popular pre-eminence which is well established.

Thirty years ago I introduced *Pinus insignis* and made important plantations. One or two of these trees, now twenty-seven years old, stand more than 100 ft. high, with a sturdy corresponding bulk, constituting, with their longer, softer, light green, three-sheathed needles, a handsomer and more attractive form than seen in the Pinaster. But though of equally rapid growth, the cultivation requires more care than the Pinaster; neither is the tortuous-fibred wood regarded with favour by the working carpenter.

P. pinaster, P. canariensis, and *P. insignis* all hold their cones for indefinite periods, but the Himalayan *P. longifolia* sheds all its produce in September, leaving nothing but the embryonic promise of next year's crop, the substantial development of the large cones with their resinous, club-ended bracts occupying only seven months.

I cannot close this account without a reference to *Cupressus macrocarpa* and *C. goveniana* as recent accessions of great promise to the Madeira show of conifers; and some mention is also due to the Douglas fir, *Taxodium sempervirens,* etc., stately examples of which adorn our mountain-gardens.

Madeira, June 29. MICHAEL GRABHAM.

The Training of Practical Entomologists.

THE increasing demand for fully trained economic entomologists was, I think, evident to all who followed the proceedings of the recent Imperial Entomological Conference held in Burlington House. We are faced with the difficulty of ensuring an adequate supply of keen and experienced young men fitted for service in India, the Soudan, and other of the British dominions wherever the requirements may be greatest. The solution of economic problems in entomology is far more difficult than is commonly supposed, and only men of the broadest biological training, coupled with the gift of imagination, are likely to achieve results of lasting value to the community. Under present conditions they are frequently called upon to take up responsible positions after inadequate training and with only a modicum of practical experience. In the training of an economic entomologist two obvious pitfalls have to be avoided: one is a too exclusively academic or laboratory experience, while the other is a too specialised training in economic entomology at the expense of the necessary preliminary grounding in general biology.

The majority of practical entomologists become attached to an agricultural department, a smaller number enter a forestry department, and it is evident, therefore, that they need to acquire some knowledge of the principles and practice of either agriculture or forestry. The time at a student's disposal is an important factor, and the majority of men can usually only devote four years to training prior to turning out and earning their living. Let us take, for example, the course of a student at Cambridge. If he possesses good abilities, he should be able to take Part I. of the Tripos at the end of the second year and obtain his preliminary grounding in biology and chemistry, and I would suggest that the remaining two years should be devoted to entomology *plus* agriculture. The diploma course in agriculture might well be modified to suit such students, allowing them to devote as much time as possible to entomology, and confining the agricultural training, so far as may be feasible, to a knowledge of the soil and crop cultivation, omitting the greater part of the course dealing with stock and animal nutrition. In so far as entomology is concerned, I would advocate the first year (or the student's third year) being devoted entirely to what may be termed the scientific side of the subject. The second year (or the student's last year) should be given to as full a training as possible in economic entomology with the necessary field work. He should be given every opportunity for observing the common pests in the field and the methods of dealing with them. I strongly advocate every student also being given an independent piece of life-history work to

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follow out, in order to acquire methods of accurate observation and technique. This work should be written up and modelled in the form of a scientific paper, and illustrated so far as may be desirable. By means of such an essay the student will become familiar with the elementary procedure in research work, he will acquire some power of independent observation, and learn how to deal with entomological literature, thus gaining some idea of the sources where he will find first-hand information.

Furthermore, I would also insist upon the student forming a small but thoroughly representative collection of insects, so proving that he has had some field practice in collecting, and is able to refer them to their families and genera. By means of such a course as I have outlined, it should be possible to train good, all-round entomologists, capable of tackling a problem unaided when out in the wilds of Africa or the plains of India.

If the student can spare a fifth year, it would be all to his advantage, and the time would be most profitably spent in prosecuting some line of independent entomological research. A. D. IMMS.

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The Separation of the Isotopes of Chlorine.

IN order to prevent confusion of issues, instead of Cl and Cl′ let us write A and B. Then when we say that A and B are identical, we mean that all the properties of A and B are the same except that of position occupied. Thus we are enabled to divide the atoms into two groups, the A group and the B group, in spite of their identity of properties. Then it is quite certain that if the atoms exist as molecules A_2, B_2, and AB, in equilibrium by the reversible reaction $A_2+B_2 \rightleftharpoons 2AB$, the equilibrium is given by $[AB]^2/[A_2][B_2]=K=4$.

The following considerations will, I think, meet any difficulties that have been raised in reconciling this reaction with Nernst's heat theorem. In the case of complete identity, if we convert the solids A_2 and B_2 into the solid AB by evaporation to the gases A_2, B_2, transformation into the gas AB, and condensation to the solid AB, we obtain an increase of entropy of $R\log 4$. But this solid is really a solid solution or mixture, since, as we assumed that the vapour pressure over it is equal to the pressure over the solids A_2 or B_2, we must assume that the molecules condense on its surface with "longitudinal indifference." The solid, then, is a solution of the molecules AB in BA.

Now the entropy of a body consists of two parts, one depending on the distribution of velocities, the other on the distribution of the co-ordinates of position. The first term cannot give rise to any change of entropy when the solids are transformed, irrespective of Nernst's theorem, but the second term is a constant, and accounts for the change of $R\log 4$. It may, in fact, be calculated directly by statistical methods.

If we assume that the gas AB condenses to the solid AB (or BA) instead of into the solid solution, then we must take the pressure over this solid as double that over A_2 or B_2, and not equal to them; because, consistently with the assumption of the formation of the pure solid AB, we must assume that the solid rejects half the molecules which strike its surface; that is to say, the molecules AB condense, but not the molecules BA.

This double vapour pressure will make the entropy of the two gram-molecules of AB (or BA) equal to the entropy of one gram-molecule of A_2 *plus* one gram-molecule of B_2.

No essential difference in the argument is made when A_2 differs slightly from B_2.

Prof. Soddy throws out a suggestion for the removal of the term $R\log 4$ which surely must be erroneous. He seems to agree to the distribution of molecules given by $[AB]^2/[A_2][B_2]=4$ (which must result whatever kinetic process be assumed), but he considers it wrong to write 4 as the equilibrium constant of the reaction $A_2+B_2 \rightleftharpoons 2AB$, as this gives for the coefficients of the reaction velocities $k_1=4k_2$. He therefore would write the reaction $A_2+B_2=AB+AB$, and then, taking half the concentration of AB, write $[\frac{1}{2}AB][\frac{1}{2}AB]/[A_2][B_2]=K=1$. Therefore $k_1=k_2$.

To write this reaction in this form is unjustifiable. In the first place, that $k_1=4k_2$ in no way contradicts the assumption of the identity of A and B. For the velocity coefficients do not depend only on the properties of the atoms or molecules involved, but contain a factor depending on the statistics of the reactions. In this respect the direct and reverse reactions may be different. This is better seen by comparing the two reversible reactions $2A=A_2$ and $B+C=BC$, where A, B, and C are identical atoms. The two reverse coefficients are equal, $k_2=k_2'$, but the two direct coefficients are not equal, for $k_1=\frac{1}{2}k_1'$. This is because *n* atoms B, together with *n* atoms C, give twice as many B–C collisions as *n* atoms of A give A–A collisions. If we write the reaction $A+A \rightleftharpoons A_2$, and take half the concentration of A, we still do not find $k_1=k_1'$, but $k_1=2k_1'$.

In the second place, to write the reaction $A_2+B_2 \rightleftharpoons AB+AB$ suggests that we can divide the molecules AB into two equal sets, and that a significant collision only occurs when an AB molecule from the first set collides with an AB molecule from the second set. Finally, the semi-permeable membrane that may be used in calculating the change of entropy due to the gaseous reaction must be assumed permeable to all or none of the molecules AB, thus giving an entropy change $R\log 4$. So that by no considerations whatever are we justified in taking half the concentration of the AB molecules when calculating the change of entropy. ANGUS F. CORE.

The University, Manchester, July 24.

Anticyclones.

PROF. HOBBS in NATURE for July 22 gives some experimental reasons for contending that over large ice-covered areas, such as exist in Greenland and the Antarctic continent, the cooled lower layer of air moves outwards in all directions from the centre of the ice-covered area. Under the influence of the earth's rotation the air thus set in motion is regarded as circulating as in normal anticyclones, and Prof. Hobbs on that account speaks of such areas as being anticyclonic. He remarks: "The centrifugal nature of this motion tends to produce a vacuum above the central area of the ice mass, and the air must be drawn down from the upper layers of the atmosphere in order to supply the void. It is here that is located the 'eye' of the anticyclone." He thus postulates an anticyclone with a *low-pressure centre*.

With the physics of Prof. Hobbs's theory there need be little criticism. The point really seems to be: Are the conditions described by him as existing over an ice-cap anticyclonic? An anticyclone has a high-pressure centre, and a cyclone a low-pressure centre, the surface air moving outwards in the former and inwards in the latter, whereas the conditions described by Prof. Hobbs are an *outward flow* and a *low-pressure centre*. Would it not be well to designate such conditions by some other word?

R. M. DEELEY.

Tintagel, Kew Gardens Road, Surrey, July 23

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